Mechanical Properties of Densified Tectosilicate Calcium-Aluminosilicate Glasses

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Aluminosilicate glasses are widely used in applications such as LCD glass, touchscreens for hand held devices and car windows. We have shown that the tectosilicate compositions exhibit an interesting non-monotonic variation in hardness with increasing SiO_2 content. From 40% to 85 mol% SiO_2, hardness and indentation modulus both decrease, consistent with the topological constraint theory. Above 85 mol% SiO_2 , hardness increases rapidly with increasing SiO_2 content while modulus continues to decrease. A switch from shear to densification based on the species present in the glass has been proposed to explain this behavior. To reduce densification and study shear deformation independently, a series of calcium aluminosilicate glasses with tectosilicate compositions were densified by isostatic compression in a gas pressure chamber at elevated temperatures. The compressed glasses have increased elastic modulus and hardness in comparison to their uncompressed counterparts. Structural changes during compression can inform mechanisms of deformation at the atomic scale, and linking unit deformation mechanisms to hardness is key to developing glasses that exhibit desirable mechanical properties like resistance to brittle fracture.